

ANALYSIS OF SHADING PATTERN OF SOLAR PANELS

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Abstract

Abstract –The shading pattern of a Solar Panel if analyzed helps to improve the performance of a Solar panel. Shades on top of a Solar Panel are one of the major factors which causes disturbance on a solar panel. This paper helps analyze the shading on a solar panel which is caused by steady clouds. This may help to increase the efficiency of a solar panel. Various methods of Image processing technique is used to get the desired output. Those methods include techniques like median filtering and various morphological functions like usage of structuring element which gives the desired output. The problem of Boundary Estimation of a shading patter on a solar panel is addressed. Short-time shading and lightning is not at all useful for solar power plant. If the solar panel is shaded then proper measures have to be taken to keep the efficiency intact else there would be a serious loss in the amount of current generated with the help of a solar panel. Here the pixel values are measured and thus the exact numbers of dark and bright pixels are calculated and even the pixel values are reconfigured to get the correct boundary estimation. The bypass diode is used to bypass the shaded area on the panel, which in turn helps to increase the efficiency of a solar panel by a significant amount. This method takes care of processing all kinds of shade on the solar panel from whatever source the shade is generated from. This concept can be taken further to analyse the various other parameters for effective operation.

Key Words: Cloud; Solar power plant; Partial shading; Image processing; Efficiency; Bypass diode

1. INTRODUCTION

The use of solar energy dates from antiquity. Between 1907 and 1913 the American engineer F. Shumman developed solar driven hydraulic pumps. With the increasing availability of low-cost oil and natural gas, interest in solar energy for power production is needed. Much amount of work was not done on solar energy from 1915-1950, but the interest was initiated by the American Association for the Advancement of Science at Washington DC in 1949 in the section of “future energy sources”. At that time the future potentials as well as the economic problems for solar power was discussed. The wide spread discussion of solar energy was done only after the oil-embargo that occurred in 1973[5].

The performance of a PV array can be affected by various factors, such as temperature, solar isolation, solar angel of incidence, shading, inclination, angel of panel and array configuration. The power output of a solar panel depends on the solar intensity and angel of a PV array. A PV array can get shaded or partially shaded by various factors such as trees, clouds, buildings etc [2]. Thus monitoring of an PV array needs to be done for maximum output of a solar panel.

This method can be used for the boundary estimation of anything which would require an exact estimation and pixel count. After this boundary estimation method is compiled

with, the solar panel could be attached with bypass diode to get the good results of the amount of current produced. Some researchers used to use blocking diode on a solar panel to stop the current from getting into an infinite loop in the circuit itself, but the blocking diode itself does not help to safeguard the solar cells or provide any protection to reduce the output current according to the shading patterns on the solar panels.

Thus bypass diodes are used which are far more useful than a blocking diode and provides complete safety against any fluctuations which may cause the peak voltage to change in a particular situation.

The maximum current obtained from an solar panels or an array does not only matter only on the size (the number of panels on an array) but also how the configurations (connections of the panels) and the way the shading pattern is handled by a solar panel. Thus all the factors have to be taken care for the increase in the efficiency.

2. STIMULATION PROCEDURE

The reason for using MATLAB is that it is available in most academic, research, and industrial organizations and considered useful for several engineering disciplines. It provides several features that can be used to simulate highly

complex systems, electronic and power electronic circuits and

systems and distributed generation power systems. To get the input image a simple camera is used with a good pixel count, so the clarity of the image remains intact.[1]

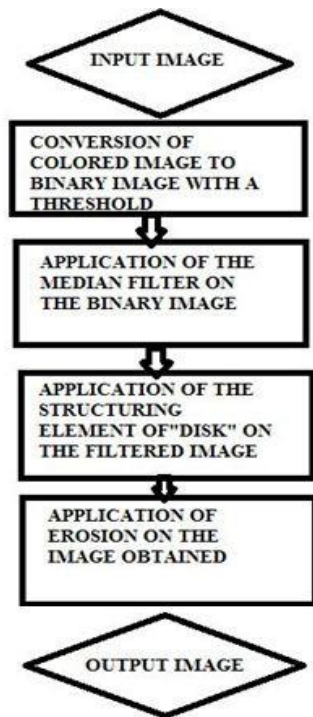


Figure 1- Flow Chart of the Stimulation Procedure

2.1 Conversion of colored image to binary image

Here a simple predefined function in MATLAB is used for the conversion of colored image to binary image.

2.2 Application of median filter on the binary image

This is a nonlinear digital filtering technique which is used to reduce and remove the noise (disturbances in an image). This stage usually aids to get better results in the following procedures to be performed. In this application method a window would be applied on the entire image. The pixel value in the entire image is taken into consideration and the median value of it is the intensity value of the output pixel.

2.3 Application of structuring element

This is a set of non linear functions usually related to shape or morphology of an image. The morphological functions do not deal with the intensity value of an image. Here the relative positions of the pixel values are dealt with according to the neighborhood pixels.

In this procedure another kind of window is applied all over the image. These windows are called structuring elements and these come in various shape. User uses whichever shape according to the usage.

For example, this code creates a flat, diamond-shaped structuring element.

```
Se = strel ('diamond',3).....1
```

Decomposition: 3 STREL objects containing a total of 13 neighbours

Neighbourhood:-

0	0	0	1	0	0	0
0	0	1	1	1	0	0
0	1	1	1	1	1	0
1	1	1	1	1	1	1
0	1	1	1	1	1	0
0	0	1	1	1	0	0
0	0	0	1	0	0	0

Comparisons of the structuring element along with the neighboring pixels are done and thus the approximate shape of the object in the image can be identified

The structuring elements work better in a binary image because the structuring element is usually a window of different shapes having intensity value of the image as either zero or one.

Here the structuring element of “disk” is being used here.

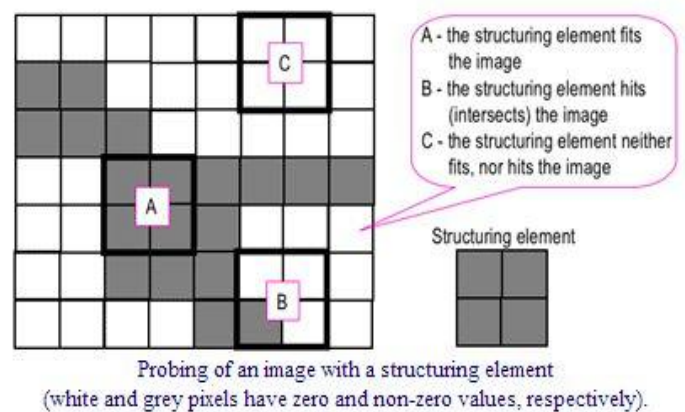


Figure 2- Structuring Element having the shape “square”.

2.4 . Application of Erosion.

Morphological operations include the application of erosion and dilation too. Erosion is used to remove pixels from the boundary of an image object, detected earlier in the procedure.

Erosion will occur according to the neighbourhood pixels of an image. Erosion might cause the boundary

pixels of an image to either go dark or light according to the neighbourhood pixel intensity value[10]



Figure 3-Original image of a flower

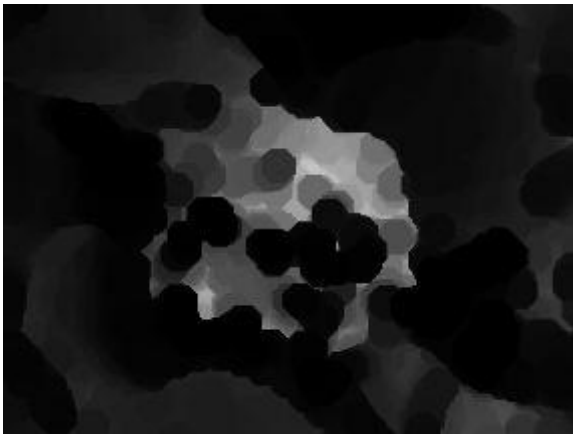


Figure 4-Eroded image of a flower

2.5.OUTPUT IMAGE

The output image obtained would be used to differentiate between the dark area and the light area and thus the bypass diode would work according to amount of light area available on the solar panel[3]

This way the solar cells which maybe shaded due to any obstruction may be easily bypassed with the help of bypass diode.

This analysis would help us to get the current with minimal loss and thus a significant increase in efficiency.



Figure 5-Original Picture of the Clouds



Figure 6-Boundary Estimation done by the algorithm used

3 .SOLAR CELLS

Photovoltaic is a method to generate electrical energy by converting solar energy into direct current electricity using semiconductors which exhibit photovoltaic effect.

Materials used for manufacturing of photovoltaic's are monocrystalline silicon, polycrystalline silicon, amorphous silicon, cadmium telluride, and copper indium gallium selenide/sulfide.

Photovoltaic is used for power generation by including multiple solar cells together and then forming an array of solar cells.[4]

The operation of a photovoltaic (PV) cell requires 3 basic attributes: 1.absorption of light, generating either electron hole pair or excitons.2.separation of charge carriers of opposite types.3.The separate extraction of those carriers to an external circuit.

Photovoltaic's is the direct conversion of light into electricity at the atomic level. Some materials exhibit a property known as the photoelectric effect that causes them to absorb photons of light and release electrons. When these free electrons are captured, an electric current result that can be used as electricity [12].

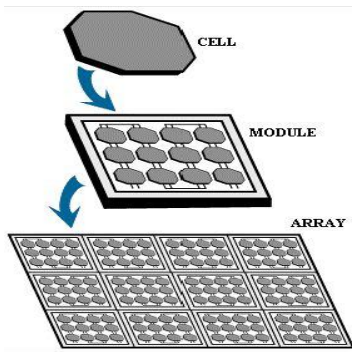


Figure 7-Forming of a PV array

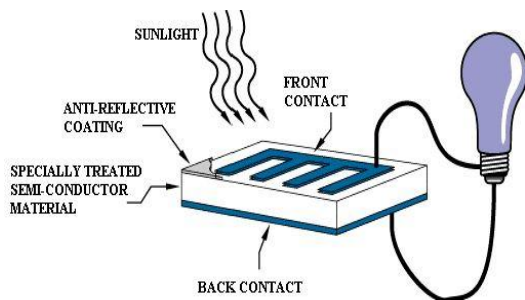


Figure 8-Working Of an PV array

4.BYPASS DIODE

Bypass diode are used on a solar panel for two reasons

- i) To provide improved safety to the panels
- ii) To help improve the performance and thus improve the efficiency of the Solar panel[11].

The primary reason that bypass diodes are used is to prevent the operating voltage of the module and the series string from getting too low if a panel has any partial shading. The shaded portion of the panel is, as the name suggests, bypassed [7].

A partially shaded SOLAR panel will always try to get the maximum output. Under shaded conditions also, a Solar Panel will always try and give maximum output, which

causes the solar panel to give more output then possible, which causes loss of current and also increases the circuit temperature. Eventually causes the life of the circuit to reduce and also reduced outputs.

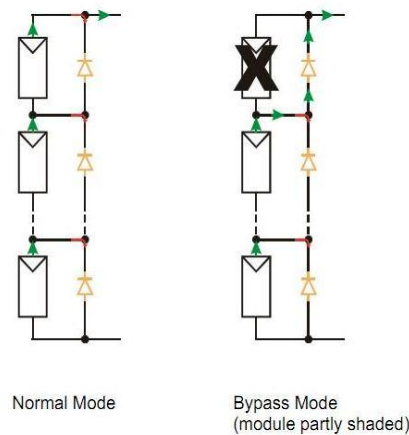


Figure 9-Bypass diode in normal mode and in bypass mode

So the bypass diode helps to reduce all the disadvantages of the solar panels and hence improve the overall output and thus improve efficiency.

The bypass diodes which are attached to the solar cell are usually at a reverse bias mode, thus allowing current to completely pass through it. The moment even a small percentage of the solar cell gets shaded due to any reason, the bypass diode switches from reverse bias to forward bias thus allowing the current to completely bypass the shaded cells.

This may cause the output voltage to reduce ,but atleast the effects of shaded cells causing damage to the whole array will significantly reduce[6-8]

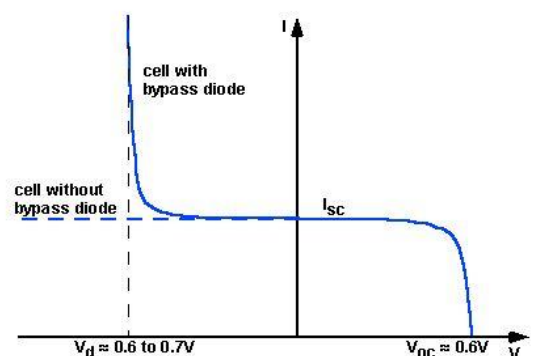


Figure 10-Output Characteristics of the solar panel with and without bypass diode.

A single Bypass diode might be used for multiple solar cells together. That is usually done because a single bypass diode for every single cell would not be feasible because of the increased cost[9].

5. TEST RESULTS



Figure 11- Original picture of the solar panel

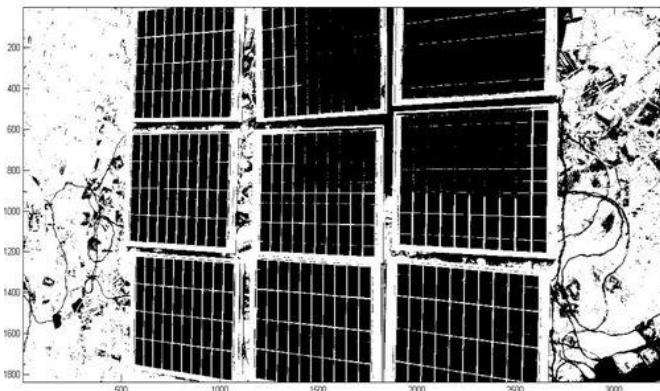


Figure 12-Boundary estimation done to the original picture of a solar panel.

6. CONCLUSIONS

This procedure consists of separating the dark pixels from the bright pixels and giving an exact count of the number of dark pixels and bright pixels. It is very important to understand the MATLAB program used to differentiate the dark and bright area. This procedure has a step wise routine which includes various methods to convert the binary image to complete black and white along with the pixel count.

After the boundary estimation is done, a bypass diode can be used to bypass the solar cells which are partially shaded and thus the efficiency of a solar panel can be improved

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BIOGRAPHIES



Gargi Sarkar completed her Btech in Electronics from Mukesh Patel School of Technology Management and Engineering, affiliated to NMIMS University in 2012. She has continued to study for her MTECH degree and is currently pursuing her master's from Mukesh Patel School of Technology and Management and would be graduating by 2014.



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